ROOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-77-3

SUPERIOR BLUEGRASSES FOR ROADSIDE TURF

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Interim Report

SUPERIOR BLUEGRASSES FOR ROADSIDE TURF

TO: J. F. McLaughlin, Director
Joint Highway Research Project

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

January 11, 1977
Revised July, 1977

Project: C-36-48E

File: 9-5-5

Attached is the revised draft Interim Report titled "Superior Bluegrasses for Roadside Turf" originally submitted in February 1975 and after review returned for revisions. The attached Interim Report dated Revised January 11, 1977, is the resubmitted one of February 4, 1976, with many changes.

The Interim Report documents the development and selection of a new bluegrass cultivar, proposed name "Wabash", and includes much of the documentation material which would be used in a patent application. The Report has also been expanded to include the actions taken to increase seed supply of Wabash; the results of the first years seed supply increase; discussion of subsequent seeding of large experimental plots on an Indiana roadside, recommendations as to the patenting of Wabash and development of the seed to its marketing phase and thereafter, and as an Appendix the "Determination of Rights" as approved by the Department of Transportation in May 1977.

The development of this Report has been difficult due to the requirements of effective seed development practices and the agreements felt desirable to establish that it may be possible to establish an effective procedure for effective development and marketing of Wabash. It now appears that an effective procedure is possible and the attached Report is submitted.

The Report is submitted for acceptance as partial fulfillment of the objectives of the Study.

Respectfully submitted,

Harold L. Michael
Associate Director

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Interim Report

SUPERIOR BLUEGRASSES FOR ROADSIDE TURF

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From the study "Superior Bluegrasses for Roadside Turf".

16. Abstract

This Interim Report documents the characteristics of a new bluegrass developed as a result of research on promising selections over the past several years. The selected bluegrass has characteristics which make it very promising as a highway roadside turf. It is a distinct variety characterized by a light green color, a vigorous rhizome spread, a medium tall seedhead and unusually uniform (apomitic) character. Increase in seed supply activities; further roadside experimentation with the new bluegrass, tentatively named Wabash; and a recommended plan for patenting, maintenance of the seed stock, development of the production and marketing of the new seed, and supervision of such production and marketing so that the integrity of the new seed is insured are also outlined.

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INTRODUCTION

An original Research Study titled "Improvement of Kentucky Bluegrass Through Selection and Breeding" was completed with submission of a Final Report (JHRP-72-8) in July 1972. The objective of that project was to select and develop varieties of Kentucky bluegrass which possessed characteristics that would permit them to adapt and compete under roadside conditions. Plant characteristics originally considered most important were:

1. Rapid aggressive rhizome growth for early establishment and superior long term competitive ability for maintenance of slopes.
2. Low growth characteristics to reduce mowing frequency requirements.
3. Plant disease resistance.

A low growth habit was felt to be one of the most desirable characteristics. This was in light of the potential economy that could be realized through the reduction of costs necessary for roadside mowing and costs related to mowing equipment and fuel and labor costs. The initial years of work on the original study were directed toward low growing varieties.

It was also assumed that a superior turf-grass would need only outperform existing combinations of Kentucky bluegrass, tall fescue, perennial and annual rye, and to be propagated by seed. Past observations have confirmed that, through natural adaptation of species, bluegrass becomes the more dominant grass existing along Indiana roadsides. Throughout the cool, humid region of the United States, its persistence illustrates its adaptability to this climate. In addition, the present practices for mixtures of tall fescues, annual and perennial rye, and common Kentucky bluegrass have exhibited problems in mowing and erosion control. Consequently, a vigorously spreading bluegrass, with good disease tolerance, should be

valuable in development of a uniform weed resistant turf. It would minimize maintenance as less erosion problems would result and less frequent weed control would be necessary. If in addition the bluegrass was low growing, less maintenance would be necessary.

For many years common Kentucky bluegrasses from midwestern, northwestern or foreign sources have been used for roadside planting. Although improved bluegrass varieties have been developed, selections were not made on the basis of roadside adaptability but rather for lawns and recreational turf. Of these improved types, some require heavy fertilization, have a yellow leaf color, fine leaves which fall over quickly, or produce an excess of stemmy seedheads. Selections were not made for rapid establishment, ability to compete, low seedhead heights, and disease resistance, all of which are characteristics required of a good highway turfgrass.

A very diverse, sexual parent of Poa pratensis L., Kentucky bluegrass, called 16B, had been included in the bluegrass turf research program at Purdue since 1952. From this parent over 100 seedlings, different from the parent, have been selected. These included several very fine dwarf types as well as broader leaved types with vigorous growth and aggressive spread characteristics as would be preferred for highway use. The primary bases for selection over the years of improved bluegrasses for roadside turf has been the characteristics of low growth, abundant and vigorous rhizome and tiller formation and disease resistance.

Intensive activity in selecting and propagating improved types was started in 1965 by T. P. Riordan and W. H. Daniel under the initial HPR project in this area. Resulting selections of seedlings have been transplanted as space plantings every year since 1965. These plantings were

the source material for over 15,000 individual bluegrass plants which were screened for grasses that would provide a superior roadside turf. Data from the 1965, '66 and '67 screening process is included in the JHRP Progress Report, "Research on Roadside Development and Maintenance, Part I, Bluegrass Research" by W. H. Daniel and T. P. Riordan, dated 1968.

In making selections, nine characteristics were measured - leaf height, spread, rust resistance, leaf color, panicle height, panicle quantity, panicle maturity, winter survival and overall rating. Five selections were made for each of low, medium and high leaf heights. It was becoming clear at that time that medium and higher growing plants, because of more vigorous spread, might be best for roadsides.

Research results and program progress from 1968 through June, 1972, are reported in the JHRP Progress Report No. 25, "Improvement of Kentucky Bluegrass Through Selection and Breeding" by W. H. Daniel, 26 July 1972. This report discusses performance of selections which had been planted on highway roadsides in experimental plots and also reports on the selection of 13 superior bluegrass types that had been further evaluated. With this Report the initial study was terminated and a new HPR Study was initiated.

THE CURRENT RESEARCH

The objectives of the new HPR Study titled "Superior Bluegrasses for Roadside Turf" were as follows:

A. To continue to test the selected experimental bluegrasses under roadside conditions and to select one or more of the most promising.

B. To increase the seed supply of the selected bluegrass and determine germination and uniformity.

C. To expedite the early stages of seed production, processing and planting of the new variety.

D. To coordinate the implementation of use of the new variety through education and demonstration with the highway department.

From July 1972 to the winter of 1974, observations of the roadside plots and the space plantings at the Agronomy Farm of the thirteen (13) selected types continued. Characteristics important to roadside use, especially aggressive spread, disease resistance and growth height, were periodically measured, compared and evaluated. Finally in January 1975, one type was selected as the most promising for roadside use.

The selection of this new variety resulted from observations by the principal investigator of space plantings at the Agronomy Farm and evaluations of this variety and its parents during the breeding and selection process, 1952 through 1975. The selection was based on demonstration of the following characteristics: apomixis, vigorous spread, disease resistance, color and drought tolerance, seedhead height and seed viability.

CHARACTERISTICS OF WABASH

Apomixis

Apomixis is reproduction without any form of sexual union. Kentucky bluegrass plants range from highly sexual to highly apomictic; however those which reproduce apomictically remain true to type while those which reproduce sexually tend to produce plants which may have different characteristics. For a new seed, uniformity of reproduced plants is obviously very important.

In June 1970, the population of this plant were confirmed as uniform, apomictic, with a high degree of apomixis. This finding was reported in JHRP Progress Report No. 25, July 1972. Appendix A of that Report is a technical report titled "Selection of Poa Pratensis L. (Kentucky Bluegrass)" by T. P. Riordan. Table 3 of that Report, included here as Table 1, with entries 1 and 28 underlined illustrates that in the third generation the seedling 23-14 of 16B1 was still producing quite variable progeny. However, based on data presented in Riordan's thesis, by the fourth generation, 16B1 progeny were apomictically superior cultivars with no or few off types developing (see attached Table 2). In that Table seedlings 23-14, the fourth generation of the eventually selected new variety, were in fact most uniform. In 70 seedlings of the fifth generation (A4) no off type seedlings were found. By 1975 the seventh generation of 16B1, ie. 1W19N, had only two off types in 300 seedlings. This is assurance that one of the superior and identifying characteristics of 16B1 progeny (1W19N) is its exceptional apomictic character.

Table 1. Selected plants and data for experiment 1, organized from most uniform (appearing apomictic) to most variable (appearing sexual).

Selection			Rhizome spread*			Leaf height(cm.)				Rust res. *	Leaf col. *	Wint. sur. *	Panicle			
	Parent	Seedling	I	II	III	I	II	III	IV				ht. (cm.)	quan. *	mat. *	
1	16B1	60-29	3	3	2	18	18	25	12	1	2	1	58	4	4	Uniform
2	16B9	8-12	5	4	3	20	20	20	15	6	5	1	72	1	5	
3	K547		5	4	4	15	20	20	15	5	4	1	48	4	4	
4	A10	60-32	5	3	2	15	18	22	12	5	4	1	58	4	5	
5	16F	1-2	4	3	2	12	18	28	8	7	4	1	65	1	6	
6	16B19	20-4	5	4	3	12	20	20	8	7	4	1	50	4	7	
7	16B167	11-23	3	3	2	20	28	32	15	5	4	1	65	3	5	
8	A10	20-34	5	4	2	15	18	20	10	6	4	1	65	4	5	
9	16B	23-19	5	2	2	15	15	18	8	3	5	1	55	3	3	
10	16B9	8-12	3	1	2	22	25	32	22	2	4	1	62	2	3	
11	16B18	55-24	7	5	3	5	12	18	12	3	5	1	60	6	5	
12	16B18	55-24	8	7	4	8	8	8	10	6	5	1	45	6	6	
13	16B6	31-15	3	1	2	12	15	12	10	4	5	1	65	1	4	
14	16B34	31-24	7	5	5	22	22	20	12	6	5	3	58	4	4	
15	A10	30-2	4	4	2	15	22	25	8	6	4	1	62	4	4	
16	16B9	34-18	3	3	1	12	22	20	20	7	3	6	60	3	4	
17	16B34	43-14	6	3	4	14	18	8	8	5	4	1	58	3	5	
18	16B18	11-16	4	3	3	18	12	12	8	6	4	1	62	3	4	
19	16B9	50-31	4	2	2	18	20	18	8	7	2	5	68	3	5	
20	16B9	19-28	5	2	2	8	18	15	8	5	5	1	65	1	4	
21	16B1	30-14	4	2	2	15	22	28	12	7	5	1	60	2	5	
22	16B1	30-14	3	5	1	15	22	25	10	7	5	1	65	2	4	
23	16B9	38-18	5	3	3	12	18	18	8	2	4	5	55	5	5	
24	16B9	48-31	3	1	1	12	15	12	8	9	5	2	60	4	5	
25	A10	48-34	5	2	1	10	18	12	10	5	3	7	60	4	5	
26	A10	47-21	4	1	1	15	25	28	10	6	4	1	62	4	5	
27	Pig.6	30-19	4	5	4	20	18	15	10	6	3	4	55	4	5	
28	16B1	23-14	5	2	2	15	22	25	10	5	4	1	60	1	4	
29	16B	37-7	5	4	4	12	18	18	10	2	4	1	65	4	2	
30	A10	20-34	6	3	2	15	25	25	10	6	4	1	60	4	3	Variable
31	16B29	59-15	6	4	5	8	18	18	20	6	5	5	68	4	2	
Range		Best	3	1	1	5	8	8	8	1	2	1	45	1	2	
		Worst	8	5	5	22	25	32	22	9	5	7	72	6	5	

*Rating 1-9, 1 best

Note: 22 of these 31 entries have the original 16B as parentage

From: Table 3, Appendix A, JHRP Report No. 25, "Improvement of Kentucky Bluegrass Through Selection and Breeding", July 1972.

Table 2. Selected plants and data for experiment 3, organized from most uniform to most variable.
Fourth generation 66-69 in 9A1

1. Rhizome spread*
2. No. of tillers / 10 plants
3. No. of leaves / 10 plants
4. Leaf height (cm.)
5. Seedling height (cm.)
6. Rust resistance*
7. Leaf color*
8. Seedling germination *
9. Rating of uniformity*
10. No. of plants like female parent
11. No. of distinct offtypes
12. Rank of average C.V. in third generation (Experiment-Rank)

	Selection Parent	Selection Seedling	1	2	3	4	5	6	7	8	9	10	11	12
1	16B1	23-14	3	4	41	12	3.7	2	2	3	1	39	0	1-28
2	16B1	23-14	3	4	36	15	4.0	9	4	5	1	39	0	1-28
3	16B1	30-14	3	2	39	18	4.8	8	4	4	1	39	0	1-21
4	16B1	30-14	3	3	38	15	4.0	8	4	4	1	39	0	1-22
5	16B1	60-29	4	5	53	27	5.2	3	3	6	1	39	0	1-1
6	16B6	31-15	3	5	46	15	5.0	8	4	9	1	39	0	1-6
7	16B9	8-12	3	9	58	16	4.7	2	3	8	1	39	0	1-2
8	16B9	8-12	3	8	65	14	4.2	2	3	9	1	39	0	1-10
9	16BB10	50-14	4	23	76	14	3.0	3	3	9	1	39	0	2-1
10	16B18	95-22	4	14	59	10	3.9	6	3	9	1	39	0	2-2
11	K547	50-26	4	29	82	12	3.6	6	3	9	1	39	0	2-6
12	16B36	93-10	3	5	66	16	4.0	2	5	8	1	39	0	—
13	16BB76	87-3	3	7	48	12	5.2	7	2	9	1	39	0	2-13
14	16BB106	90-10	5	8	43	10	3.7	6	4	9	1	39	0	2-7
15	A10	30-2	4	13	65	11	5.0	5	4	5	1	39	0	1-15
16	K547	43-25	3	3	48	18	3.8	8	5	8	1	39	0	—
17	16B29	59-15	4	1	44	15	3.7	3	3	3	2	37	1	1-31
18	16B18	55-24	3	13	43	12	6.9	7	4	7	2	37	2	1-12
19	Athens	69-1	4	8	53	11	4.7	7	5	7	2	37	2	—
20	16B9	38-18	4	5	37	11	4.4	8	3	8	2	36	2	1-23
21	16BB5/x21	46-27	4	10	58	17	4.7	5	4	9	2	35	3	—
22	WSLD	1-2	2	1	43	10	5.4	5	3	9	3	30	4	—
23	16B9	38-18	8	12	57	11	3.5	9	2	9	3	30	5	1-16
24	16BB86	13-25	3	1	40	13	5.4	6	3	6	4	20	5	2-4
25	16B24xB171	104-28	4	6	50	9	5.8	9	5	9	4	12	4	—

20 entries have the original 16B as parentage

*Rating 1-9, 1 best.

From: Table 3, Appendix A, JHRP Report No. 25, "Improvement of Kentucky Bluegrass Through Selection and Breeding", July 1972.

Vigorous Spread

One of the characteristics of the mother plant taken in 1952, and identified as 16B, was its exceptional spread. This bluegrass was one of 24 taken from predominating clones (with up to 20' spread) from fairways of the Chicago Golf Club in Wheaton, Illinois. These fairways had not been reseeded since 1931. No. 16B had the most spread. Sprigs from 16B were planted in 1952 in small plots in field 19B3 at the Purdue Agronomy Farm near West Lafayette, Indiana.

During 1962, C. W. Lobenstein, studied characteristics of progeny of 16B and other grasses and in June 1964 produced a Ph.D. thesis titled "Sod Farming Characteristics as Affected by Morphological and Physiological Factors". His findings provide confirmation of the aggressive characteristics of the bluegrass parent 16B and its early progeny. The following paragraphs and data are from that report.

Single tillers of the original vegetative selections were repeatedly grown in idealized spaced areas. In six out of seven tests, 16B was outstandingly vigorous. Total numbers of rhizomes produced from single isolated tillers were consistently greater in those bluegrass clones (16B and progeny) previously observed to be highly aggressive under natural conditions.

Data summarized on Table 3 for the 15 clones tested show that in growth periods of 120 days or more all of the 16 series clones produced more rhizomes than Merion, a standard variety. The 16B clone, most consistently the highest ranking, produced from four to sevenfold times more rhizomes than Merion. In Experiment R-1, covering 180 days, this clone produced an average of 333 rhizomes while Merion produced 44. During 1962, in 120 days from March through July, 16B produced an average of 164 rhizomes per sample; during the next 30 days this number increased to 393. In the same period Merion produced 16 and 55.

Table 3. Average total number of rhizomes developing from single tillers of 15 bluegrass clones in 7 growth periods.

	Experiment						
	R-1	R-2A	R-2B	R-3A	R-3B	R-4A	R-4B
	Days of Growth						
Clone	180	60	180	120	150	60	90
	no.	no.	no.	no.	no.	no.	no.
16-B	333a*	3.5c*	230a*	164a*	393a*	18a*	103a*
16-C	163bc	3.0c	252a	79ab	226ab	10ab	52ab
16-D	264ab	3.8bc	224a	86b	127bc	11ab	49abc
16-F	152bc	4.5abc	153ab	41cde	155bc	9ab	58abc
16-H	207b	3.8bc	218a	123ab	216b	15ab	69ab
A -6	128cd	2.5cd	--	25de	107c	8ab	41bcd
A-10	176b	6.0A	256a	73bc	198b	7b	44bcd
A-13	165bc	5.5ab	185ab	41cde	--	8ab	26cd
Shade	151bc	3.5c	150ab	88b	160b	10ab	38bcd
Dwarf	108cd	5.5ab	175ab	56cd	28d	7b	10e
Newport	91cd	1.3d	107bcd	34cde	154b	3c	22d
Common	--	2.0cd	138bc	21de	62cd	10ab	39bcd
Delta	--	1.0d	134bc	17e	99bc	9ab	29cd
K-5-47	39e	3.0c	78cd	31de	55d	8ab	13e
Merion	44e	0.8d	76cd	16e	55d	11ab	30cd

*Significant differences between means at 5% Duncan multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

In Table 4 it is noteworthy that the standard varieties - Delta, Common, Newport, and also the experimental K-5-47 - were seldom significantly different from Merion in any of the categories tested. Confidence in the data from these experiments is further strengthened by results for Newport which were consistent with commonly observed growth behavior of that variety. Figure 1 provides visual comparisons.

Total Rhizome Length

Measurements of total rhizome length disclosed even greater superiority in favor of the 16 series when compared with other common varieties. Eight of the 15 clones produced greater rhizome length than Merion in four tests of 120 days or more as shown in Table 5. As before, 16-B, C, H, and in this case F, exceeded Merion in all but experiment 4-A which involved only 60 days growth.

In Experiment R-1, as noted earlier (see Table 3) the 16B clone produced 333 rhizomes while Merion had only 44. In length for 16B, these totaled 26.6 meters while Merion totaled only 2.3 meters.

The tenfold increase for 16B over Merion noted in R-1 is portrayed in Figure 2 in C-3 where 16B produced approximately 3.3 meters rhizome growth contrasted to 0.6 meters for Merion. The average for all the 16 series clones was 4.1 meters compared with 1.2 meters for the four standard turf varieties (Figure 2).

Average Rhizome Length

Average lengths which individual rhizomes attained before merging are summarized in Table 6. Shorter lengths per rhizome were observed for Merion and other standard varieties in nearly all experiments. Average for Merion and Common in the five R- experiments was 34.6 mm and 47.7 mm respectively, while average for 16B in the same series was 54.4. Although

Table 4. Numbers of rhizomes and shoots produced per emerged crown in 60- and 120-day old bluegrass plantings from 7/25 to 8/26, 1962

Clone	R-4 60 days			R-3 120 days		
	Total crowns	Rhizomes per crown	Shoots per crown	Total crowns	Rhizomes per crown	Shoots per crown
	no.	no.	no.	no.	no.	no.
16-B	33	2.6	4.2	376	0.6	0.9
16-C	48	0.9	1.3	229	0.7	1.5
16-D	42	0.9	1.3	225	0.2	0.7
16-F	25	1.9	6.9	181	0.6	2.3
16-H	31	1.7	4.1	303	0.3	0.5
A -6	40	0.8	3.1	140	0.6	3.3
A-10	21	1.8	5.3	2.4	0.6	1.7
A-13	20	0.9	1.8	--	--	--
Shade	17	1.7	4.8	262	0.3	0.9
Dwarf	15	0.2	0.7	--	--	--
Newport	8	2.3	5.4	98	1.2	1.4
Common	30	1.0	1.9	68	0.6	1.8
Delta	24	0.8	1.5	82	1.0	1.5
K-5-47	20	0.3	1.9	157	0.2	0.2
Merion	23	0.9	3.7	94	0.4	0.7
	Average	1.3	3.2		0.6	1.3

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

R-2B Experiment, July 1962

Spread of 4 clones of Newport bluegrass. One clone loosened and turned over to show rhizomes.

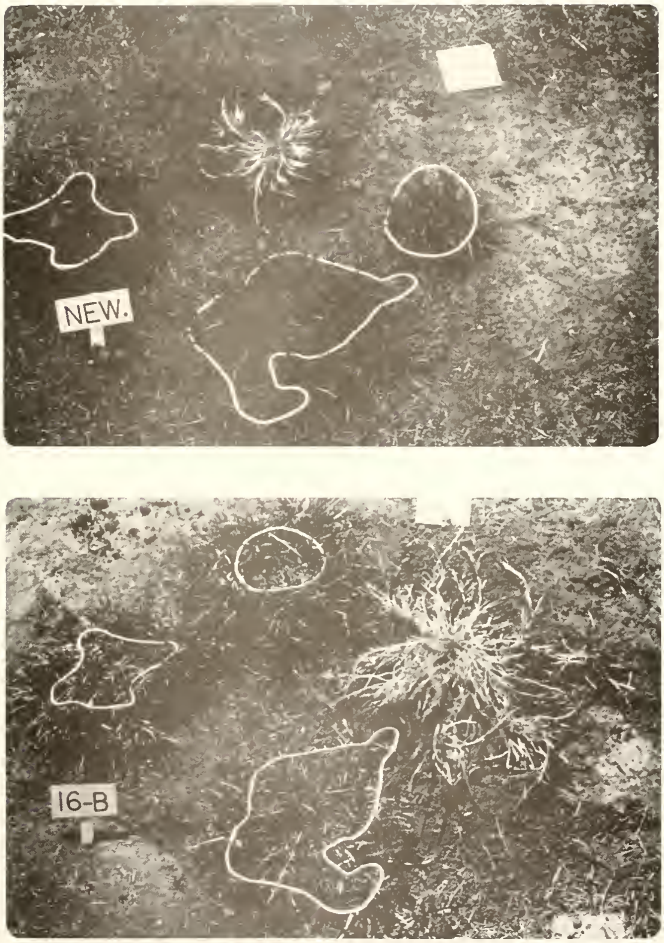


Figure 1
Spread of 4 clones of 16B with Newport outline placed above 3 for spread comparison.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

Table 5. Average total length of rhizomes developing from single tillers of 15 bluegrass clones in 7 growth periods.

	Experiment						
	R-1	R-2A	R-2B	R-3A	R-3B	R-4A	R-4B
	Days of Growth						
Clone	180	60	180	120	150	60	90
	m.	m.	m.	m.	m.	m.	m.
16-B	26.6a*	0.21c*	10.6ab*	8.3a*	25.6a*	0.68a*	6.6a*
16-C	16.8ab	0.15d	16.4a	4.7ab	17.6ab	0.54ab	4.7ab
16-D	18.9ab	0.14d	10.7ab	5.4a	7.7bc	0.39ab	2.9bcd
16-F	14.1bc	0.19c	7.8bc	3.2abc	14.3ab	0.45ab	4.1abc
16-H	17.8ab	0.21c	13.1a	7.2a	13.1ab	0.55ab	4.4ab
A-6	7.2cd	0.11d	--	1.7bcd	7.4bc	0.21bc	2.0cde
A-10	15.3b	0.32b	17.7a	5.2ab	16.1ab	0.28bc	2.8bcd
A-13	13.9bc	0.39a	10.5ab	2.7abc	--	0.28bc	1.4de
Shade	13.4bc	0.18cd	9.3ab	5.9a	10.4ab	0.43ab	2.2bcd
Dwarf	7.5d	0.29b	7.8bc	2.6abc	1.2e	0.30abc	0.4f
Newport	4.4de	0.03f	4.2cd	1.6bcd	7.9bc	0.09d	0.9e
Common	--	0.05e	6.5bc	1.1cd	3.9bcd	0.53ab	2.1bcd
Delta	--	0.03f	7.7bc	0.7cd	5.8bc	0.27bc	1.6de
K-5-47	2.5e	0.07e	3.3cd	1.7bcd	2.2de	0.17cd	0.7f
Merion	2.3e	0.02f	2.7d	0.5d	2.1de	0.29bc	1.5de

*Significant differences between means at 5% Duncan's multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

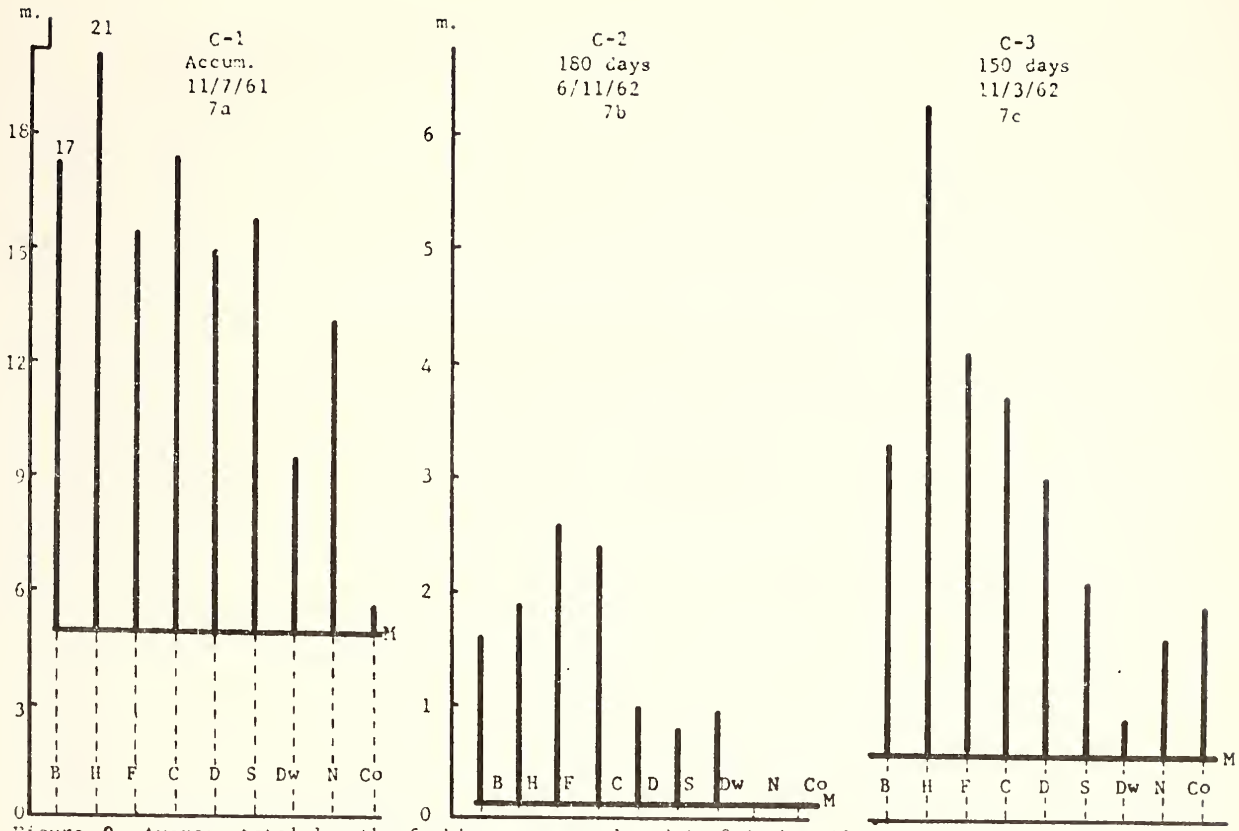


Figure 2. Average total length of rhizomes accumulated in 8-inch soil cores of 3-year old sods and entering barren cores from adjacent sods of 10 bluegrass clones in 2 growth periods.

Merion as standard is shown as cross line

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

Table 6. Average length of individual emerged rhizomes of 15 bluegrass clones in spaced plantings and in mature sods.

	Experiment						
	R-2A	R-2B	R-3A	R-3B	R-4B	C-2	C-3
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
16-B	42ab*	48bcde*	55abc*	60bcde*	66ab*	39abc*	28bc*
16-C	49ab	60ab	49bcd	77bc	78a	55a	38ab
16-D	34abc	48bcde	62ab	53cde	54bc	35bcd	36abc
16-F	49ab	54bc	74a	111a	62bc	47ab	39ab
16-H	36abc	60ab	54abc	59bcde	57bc	44ab	42a
A-6	40abc	--	38cd	70bc	50cd	--	--
A-10	59a	73a	65ab	82b	58bc	--	--
A-13	58a	61ab	69ab	--	51cd	--	--
Shade	45ab	60ab	66ab	65bcd	54bc	41abc	38ab
Dwarf	45ab	43cde	38cd	39de	29e	41abc	33abc
Newport	17c	37de	40cd	46de	38d	27d	32abc
Common	24bc	49bcd	55abc	62bcde	48cd	24d	43a
Delta	26bc	49bcde	36cd	54cde	47cd	41abc	34abc
K-5-47	22c	39cde	49bcd	36e	48cd	--	--
Merion	18c	32e	32d	42de	50cd	48ab	24c

*Significant differences between means at 5% Duncan multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors, Ph.D. Thesis, Purdue University, June 1964.

direct measurements were not made, it was frequently observed that rhizomes of 16B penetrated to unusual depths, often as much as ten inches. On such deep shoots, increased branching was observed even though the tips had not emerged and formed tillers.

Total Emerged Shoots

The total number of emerged growing shoots and the leaves on them constitute the most evident portion of a turf and is quite understandably one of its most important standards of value. Quantification of this feature involves stimulation of the successive orders of intravaginal tillers on existing crowns plus terminal shoots on newly emerged rhizomes. Table 7 shows such a summation of average growth developing in seven different periods from single isolated tillers of 15 bluegrass clones.

In this evaluation, as in the case of rhizome numbers and length, the common varieties seldom differed from Merion in tests of more than 60 days duration. Over any extended period of time clone 16B produced the highest or near to the highest total number of shoots, and Merion, K-5-47, or other common varieties usually produced the lowest number. In experiments R-1, 2B, 3A and 3B representing 180, 180, 120 and 150 days growth respectively, average shoot numbers ultimately derived from single isolated crowns of 16B were 964, 491, 305, and 818. Comparable values for Merion were: 264, 247, 91 and 186. The ratio of the two clones based on average new shoots produced per day was 41. to 13.

The diffuse type, represented by 16B spread most rapidly and so the original crown was soon indistinguishable if unmarked (see Figure 3). In this type, initial sod formation was a result of many rhizomes rather than many tillers. At the end of one year the center turf was still not as dense as a Merion turf if examined closely, but the general appearance was

Table 7. Average total number of emerged shoots developing from single tillers of 15 bluegrass clones in 7 growth periods.

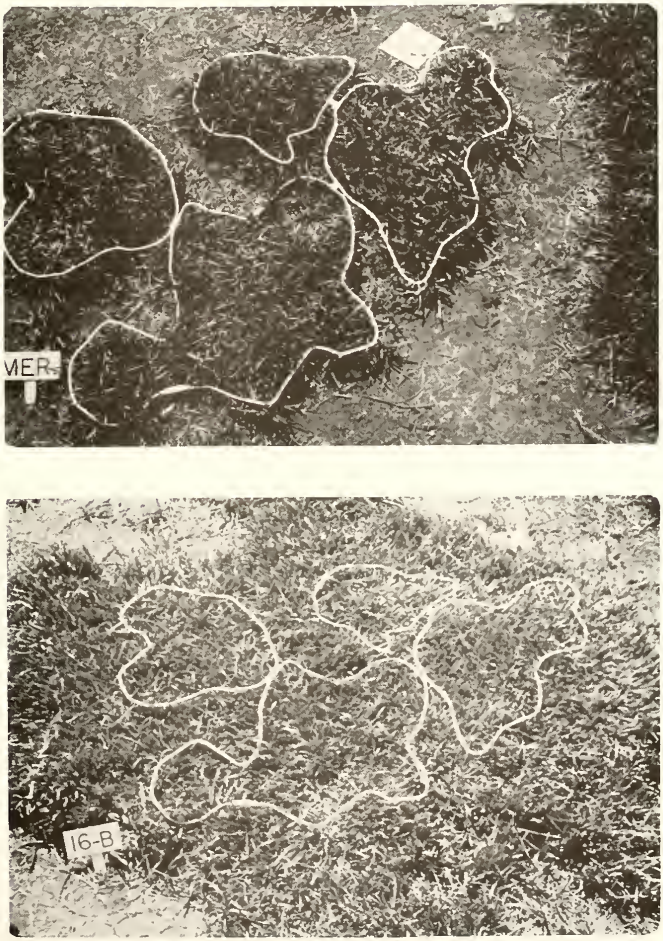
	Experiment						
	R-1	R-2A	R-2B	R-3A	R-3B	R-4A	R-4B
	Days of Growth						
	180	60	180	120	150	60	90
	no.	no.	no.	no.	no.	no.	no.
16-B	964a*	20b*	491ab*	305a*	818a*	23abc*	223a*
16-C	706ab	22b	690a	199ab	614ab	42a	132abc
16-D	862ab	22b	443ab	193ab	377bcd	34bcd	110bcd
16-F	733ab	40a	557ab	156abc	621ab	20cd	219a
16-H	600b	50a	580a	254a	491bcd	22bc	179ab
A-6	624ab	53a	--	126bcd	634ab	36ab	175ab
A-10	823ab	47a	517ab	171ab	568abc	17cd	137abc
A-13	563bc	20b	480ab	68d	--	15cd	65de
Shade	919ab	23b	457ab	218ab	501abc	11de	106cde
Dwarf	328d	11b	309bcd	94bcd	79f	11de	24f
Newport	388cd	14b	198d	92cd	300cde	7e	59e
Common	--	44a	345bcd	62d	206e	25abc	98cde
Delta	--	15b	239cd	78cd	247de	19cd	67de
K-5-47	232d	10b	188d	147abc	196e	18cd	59e
Merion	264d	16b	247cd	91cd	186e	20cd	114bcd Standar

*Significant differences between means at 5% Duncan multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors, Ph.D. Thesis, Purdue University, June 1964.

R-1 Experiment, July 1962

Spread of 4 clones of Merion as outlined by shaped wires



Spread of 16B with Merion spread indicated by white shaped wires

Figure 3

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

very satisfactory and the extent of ground cover was far superior to the slowest spreading types. This type showed evidence of having desirable highway characteristics by being able to accomplish sod formation from a few widely spaced crowns (thus surviving disease and injury)or from sparse seedling stands much more rapidly than varieties presently available.

Shoots Per Unit

Average density, expressed as emerged shoots per square inch of the occupied area are listed in Table 8. The range between high and low averages was only 17 and 9 in 120 days, and 13 to 7 in 180 days. In both cases, rank of the various clones, especially in relation to Merion, was essentially the reverse of that observed for all sod forming characteristics previously discussed. Slow spreading with abundant tiller development resulted in highest density ratings for Merion types.

The density values obtained from 14 month old sods of the D-1 test (Table 8) were much lower since they were averages of plugs taken at random from the sods, thus unoccupied areas were included in the samples. The essential point of importance from these data is that the aggressive clones did occupy larger areas more rapidly than the common varieties. Many of these clones, because of lower tillering rate, at first produced turfs of relatively low density, but within periods of six months to a year, density values for such turfs were not significantly different from Merion.

Leaf Numbers

The average number of new leaves produced by single tillers of the 15 clones during a 75 day period in the summer of 1962 are recorded as Experiment N-1 in Table 9. Average numbers produced in 72 days by six of the clones during the fall are reported as N-2 in the same table.

Table 8. Square inches of area occupied by growth from single tillers of 15 bluegrass clones in 120 and 180 days and density expressed as shoots per square inch.

Clone	D-1 120 da. (1962) Area	D-1 120 da. (1962) Density	D-1 180 da. (1962) Area	D-1 180 da. (1962) Density	D-2 180 da. (1961) Density	
	sq. in.	shoots sq. in.	sq. in.	shoots sq. in.	shoots sq. in.	
16-B	29.3	10.3bc*	53.0	9.5bc*	3.8bc*	
16-C	23.7	9.0c	61.0	10.8abc	3.2c	
16-D	11.5	16.0ab	42.5	10.5abc	--	
16-F	9.9	12.8abc	47.5	12.0ab	5.2a	
16-H	20.5	12.6abc	69.0	8.5c	4.5ab	
A -6	11.0	12.5abc	28.0	12.0ab	4.1ab	
A-10	15.5	11.3abc	44.0	12.0ab	5.3a	
A-13	7.2	10.0bc	63.1	8.3c	3.3c	
Shade	15.3	15.5ab	41.8	11.0ab	3.8bc	
Dwarf	10.3	11.0abc	31.5	10.0abc	2.6c	
Newport	7.6	9.5bc	26.3	8.0c	4.0abc	
K-5-47	8.7	17.0a	15.5	13.0a	4.8a	
Merion	6.2	16.5a	21.5	11.5ab	4.1ab	standard
Common	4.8	13.3abc	41.2	9.0bc	--	
Delta	5.5	13.8abc	35.1	7.2c	--	

*Significant differences between means at 5% Duncan multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors, Ph.D. Thesis, Purdue University, June 1964.

Table 9. Average number of new leaves produced by single tillers of different bluegrass clones in 2 1/2 month periods during summer and fall seasons.

Clone	N-1 5/20--8/4/62	N-2 9/28--12/8/62	Rank[1] Rhizome Number	Rank[1] Total Shoots	
	no.	no.	rank	rank	
A-6	12.5a*	--	11	8	
16-H	12.2ab	--	3	6	
16-D	12.0abc	--	4	7	
A-13	12.0abc	--	7	9	
16-C	11.6bcd	--	2	2	
Dwarf	11.5cd	7.3a*	9	11	
A-10	11.2d	6.5a	4	3	
16-B	11.2d	6.8a	1	1	
Common	11.2d	--	13	11	
Merion	11.0d	6.0b	14	13	standard
Shade	10.3e	6.0b	6	3	
Delta	10.3e	--	11	14	
16-F	10.2e	--	8	3	
K-5-47	10.0e	--	14	14	
Newport	9.0f	4.8c	9	10	
Avg. (15)	11.1	--			
Avg. (6)	10.7	6.2			

[1]Average of 4 experiments of 120 days or more

*Significant differences between means at 5% Duncan multiple range test indicated for entries not followed by same letter.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

The clones are ranked in Table 9 according to new leaf number. Their comparative ranks according to rhizome and total shoot numbers in the R-series tests of 120 days or more, are also shown. While differences in new leaf numbers between clones were found to be significant they were quite small.

Progeny Spread Characteristics

The generations of the selected bluegrass, 1W19N, from the original parent 16B are 16B1, A8, 23-14, 1-10-1, A4, D5-8, and 1W19N. The aggressive spread characteristics of the parent and the first generation plant 16B1 have been documented. This characteristic has remained obvious from observation and measurement through all generations to the selected one, 1W19N.

The fifth generation, A-4, in field 10B3C at the Agronomy Farm is noted in their Record Book 27, page 77, as follows:

Spring leaf height 26 cm; range 10-32 (11 May 70)

Early full regrowth 13 cm; range 7-19 (26 Aug. 70)

Color - medium

Leaf - medium

Spread - vigorous, 110 cm-fast (May 70)

Rust Rating - 6*

Leaf Spot Resistance - 2*

*Rating 1-9, 1 best.

Sod of A-4 was placed on 30 September 1970 in roadside plots at the I-65, SR-38 interchange. Notes of 3 Sept. 1971 on performance are as follows:

Plot	Density	Color	Average Height of Regrowth, in.
3	3	3	3.5
7	2	2	3.0
Range of 21 plots	2-7	2-8	1.5-5.5

In 1973 and 1974 the following measurements were made on the selected progeny 1W19N:

	Bluegrass Type			
	1W19N	Baron	Nugget	RI10
Leaf Height 19 Oct. 73 (cm)	17	13	16	28
Leaf Height 13 May 74 (cm)	23	15	10	15
Leaf Height 31 Dec. 74 (74)	12			
Dia. Spread 15 May 74 (cm)	56	52	40	51
Dia. Spread 12 Aug. 74 (cm)	90			
Dia. Spread 31 Dec. 74 (cm)	120			70
Area Spread 31 Dec. 74 (m^2)	1.13		.38	

Seedlings of 1W19N planted in greenhouse on 9 Ja 75 were rated 5, or average, on earliness and 1, as best stand. In standard seed laboratory testing, germination averaged 94% - the best of 50 experimentals tested (Range was 94 to 34%).

The rapid aggressive rhizome spread and seedling vigor characteristics of the selected bluegrass are similar to those documented for its original parent and early progeny.

Disease Resistance

Again some information is available on the disease resistance characteristics of the original parent 16B from the referenced Lobenstein 1964 Report. A general evaluation of relative foliage disease incidence in the evaluated clones was made. Subjective visual ratings of diseases present were made at critical intervals in the periods of major disease development during the 1962 season. These ratings and a seasonal summary index are provided in Table 11.

Ratings included incidence of only four diseases: Helminthosporium leaf spot and leaf blight, stripe smut, leaf rust, and an unidentified leaf blight which probably was also of the Helminthosporium complex. Recognized Helminthosporium infections were listed separately, the others were combined into a single group in the ratings in Table 11.

The summary of effect of disease indicated that, in general, greater foliage injury from diseases occurred in those clones which were superior to Merion and the common varieties in sod development. These clones thus demonstrated their more aggressive characteristics in spite of greater foliage reduction due to disease attacks under the conditions of the various experiments. Since the Helminthosporium diseases were most incident to varieties other than Merion, the fact that the aggressive clones exhibited greater susceptibilities to these diseases and still produced the better sods is most important.

In Table 11, 16B was medium to poor in disease relative to others. It continually showed some leaf spot and in July was worst. In overall index it was worst. Nevertheless, in spite of this it was at the same time producing more new rhizomes and plant parts than any other entry and its plant type and color type were retained in the experimental lines.

Table 11. Relative foliage disease incidence on 13 bluegrass clones during the summer of 1962 evaluated by visual ratings[1]

Clone	Disease	5/8	5/12	5/18	6/5	7/4	7/25	8/8	8/20	Avg. Index
Merion	Helmin.*	1.0	1.3	1.5	1.3	1.5	1.0	1.0	1.0	1.2
	Other**	1.3	2.5	3.0	2.8	1.0	1.0	3.2	9.0	3.0
K-5-47	Helmin.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Other	1.0	1.0	2.0	1.0	1.0	1.0	4.0	7.3	2.3
Newport	Helmin.	1.3	2.5	3.0	2.5	2.8	1.8	2.0	1.0	2.1
	Other	1.0	3.0	4.5	4.6	1.0	1.0	1.0	1.0	2.1
Common	Helmin.	2.0	4.3	5.6	2.6	2.0	1.3	1.0	1.0	2.5
	Other	--	4.0	5.6	1.6	1.0	1.0	3.6	4.8	3.1
Delta	Helmin.	3.0	5.3	6.6	3.6	3.3	1.0	1.6	1.0	3.2
	Other	1.0	4.3	5.6	1.0	1.0	1.0	1.5	6.4	2.7
Shade	Helmin.	1.3	1.3	2.0	3.3	2.6	2.6	2.6	1.0	2.1
	Other	1.0	1.6	1.6	2.0	1.0	1.0	3.2	7.2	3.1
Dwarf	Helmin.	1.3	2.6	4.0	3.3	3.6	2.3	2.3	1.0	2.6
	Other	1.0	2.0	3.0	2.0	1.0	1.0	4.0	7.3	2.7
16-B	Helmin.	2.0	2.3	4.0	5.0	6.6	6.6	3.8	1.0	3.9
	Other	1.6	3.3	5.0	5.3	1.0	1.0	3.3	6.0	3.3
16-C	Helmin.	1.3	1.3	2.6	3.6	4.3	5.0	2.4	1.0	2.7
	Other	1.3	1.3	2.6	2.0	1.0	--	1.6	4.4	2.0
16-D	Helmin.	1.6	2.6	4.3	3.6	6.0	3.6	2.4	1.0	3.4
	Other	1.0	2.0	3.6	2.6	1.0	1.0	3.1	7.4	2.7
16-F	Helmin.	1.6	2.6	3.0	2.3	2.6	2.0	1.8	1.0	2.1
	Other	1.0	2.3	2.6	2.6	1.0	1.0	1.0	1.8	1.7
16-H	Helmin.	3.0	2.6	2.6	4.0	2.6	1.6	2.4	1.0	2.5
	Other	1.0	4.0	3.6	3.6	1.0	1.0	3.1	7.2	3.1
A-10	Helmin.	2.0	1.0	3.0	2.3	2.0	2.0	2.0	1.0	1.9
	Other	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.3	1.2
high		3.	5.3	6.6	5.3	6.6	6.6	4.	9.	3.9
low		1.	1.	1.	1.	1.	1.	1.	1.	1.

[1]Average of 4 sample ratings on the basis of 1 as most desired resistance, 9-worst damage or least desired.

*Helminthosporium sp., leaf spot and leaf blight

**Stripe smut, unidentified leaf blight, and leaf rust.

From: C. W. Lobenstein, "Sod Farming Characteristics as Affected by Morphological and Physiological Factors", Ph.D. Thesis, Purdue University, June 1964.

As noted earlier, the fifth generation, A-4, plant showed a rust rating of 6 (medium) and a leaf spot resistance of 2 (very good).

Riordan in his evaluations of the third and fourth generation seedlings (see Tables 1 and 2) found them to rate from best (1) to worst (9) with most seedlings rating medium relative to resistance to rust.

Observation of the selected bluegrass, 1W19N, indicates that it is moderately disease resistant to rust and other diseases but that its aggressive growth results in little practical damage in turf.

Color and Drought Tolerance

Field plot observations from 1962 through 1975 show the lighter green bluegrasses stay turgid 1-2 days longer than the dark green selections such as Fylking, Nugget and Sodco. It is possible that the leaf with a lighter green color has a slightly lower evaporation and transportation rate than those with the dark bluegreen color. This is certainly an asset for the 1W19N selection in its need and ability to complete under the adversity often encountered on highway roadsides. Earlier researchers, however, were reluctant to select light colored grasses as desirable because the public was felt to favor darker shades.

A light colored grass, on the other hand, can better blend with other grasses which often tend to be light colored, for example, crabgrass, Poa annua, ryegrasses.

The selected bluegrass, 1W19N, was classified as light colored in ratings in 1974 and 1975. This characteristic may be of value on roadsides because of the indication of drought tolerance.

Seedhead Height

For most years of this study dwarfness was deemed a valuable asset and the researchers sought it as a desirable characteristic. Vigorous spread and ability to compete, however, are also important and probably of greatest desirability. In late 1974, therefore, in evaluating all the characteristics of the several types with roadside characteristics, 1W19N was chosen for its vigorous spread. Its seedhead height in 1975 was measured as 70 cm. This compares with the 82 cm of a tall common type (TVA-1)and 30 cm for a dwarf experimental type.

Seed Viability

The seed weight, as number of seeds per gram, and seed germination of 50 experimental bluegrasses were tested under the standard seed testing procedures in the Purdue Seed Testing Laboratory. Seed tested was that harvested in July 1973. Each seed test was replicated four times.

For the experimental type 1W19N (Wabash) there were an average of 4775 seeds per gram and a germination in the seed lab of 92%. The number of seeds per gram for the 50 bluegrasses tested ranged from 5,882 to 2,078 seeds with a 4175 average. The fewer seeds per gram the heavier the seed. The heavy seed has a greater potential for germination and seedling vigor. The germination percentage for 1W19N was fifth best of the 50 tested.

Summary

This report has included a brief history and summary of the characteristics of a new bluegrass from its parent plant through the generations of progeny from its initial selection in 1952 to release in 1976. As plant 1W19N it was selected for further roadside experimentation and has as its suggested cultivar designation Poa pratensis L. cultivar "Wabash". It is also proposed that it be submitted for patent protection.

The review describes the history of 16B and progeny, its outstanding apomictic characteristic, and the many years during which 16B1 and progeny have survived as a superior cultivar due to: (1) aggressive character as demonstrated in tiller development and rhizome spread, (2) good disease resistance, and (3) intermediate panicle height.

Since 1952, turf research at Purdue has contained some lines which were aggressive and spread rapidly. These always completely predominate over other adjacent bluegrasses. In early years, the investigators were reluctant to release the better ones of these types because of the prejudice favoring dark green.

The needs, however, of highway roadsides and locations of heavy wear replacement in playgrounds, parks, etc., now clearly indicate a place for light green, fast spreading, dense turf. "Wabash" (1W19N) is such a type, developed over seven generations, and it is also highly apomictic and has good disease tolerance. It was considered the best of 15,000 screened over more than 15 years of selective work.

Wabash (1W19N) is a new and distinct variety of bluegrass plant, Poa pratensis, substantially as described and illustrated, and particularly characterized by a light green color, a vigorous rhizome spread, a medium tall seedhead and unusually uniform (apomictic) character - thus different, unique and useful where vigor is desired.

The integrity of the selected bluegrass plant Wabash as subsequent populations are developed through seed increase is of utmost importance. Variability in seed production and contamination of strain purity must be avoided as this weakens plant performance. This requires that the selected cultivar be patented and that a seed development and distribution process be developed which will insure the integrity of the new bluegrass. These requirements are discussed in the next sections of this report.

INCREASE OF SEED SUPPLY

The selected bluegrass, tentatively proposed as named Wabash, requires further experimentation under actual highway roadside seeding, development and maintenance conditions to test its ability to develop and maintain a desirable and improved turf. In the selection and development process to date the care of the seedlings has varied from most intense in the greenhouse and in selection plots at the Purdue Agronomy Farm to reasonably similar to care afforded turf by the Indiana State Highway Commission at some of the roadside plots. Nevertheless some extra care, fertilizing and maintenance was usually given to the turf. It is expected that strong aggressive turf will quickly develop under standard highway seeding, growing and maintenance conditions but it is desirable to test Wabash specifically under such conditions.

As a result it was necessary to increase the seed supply of Wabash to provide for sowing as quickly as possible one or more large roadside areas. The only quick way to increase seed of bluegrass is to seed a sizeable breeder field in an area where bluegrass seed will develop. The northwestern section of the United States has the climate and soil best suited to this task and has been used by the Agronomy Department of Purdue University for similar increase of other bluegrass types.

Purdue University in its School of Agriculture also develops many new seeds of various agricultural crops and has used an organization known as AGRICULTURAL ALUMNI SEED IMPROVEMENT ASSOCIATION, INC. (AASIA) as the contractor to increase seed through seed contracts with growers in the northwest. Such development has worked well in increasing seed supply as well as in later seed development and marketing arrangements.

As a result and upon recommendations of the principal investigator and because of the need for rapid increase in the seed, the Joint Highway Research Project Advisory Board at a meeting in August 1975 approved an agreement between the Joint Highway Research Project (JHRP) and the AASIA to increase the seed supply of Wabash.

Breeder seed of Wabash obtained during the research by the principal investigator was subsequently delivered to AASIA who contracted with a grower in Oregon to seed a plot of land. Seed available was sufficient to seed 2.59 acres.

In making the above arrangements to increase the seed supply of Wabash so that sizeable roadside experimental plots could be sown, assurance was secured that the integrity of the new bluegrass or of a plant patent for it would not be jeopardized.

Increase of the seed supply was one of the objectives of the current research and it is being effectively accomplished by the process described in a most responsible manner. The production field was seeded under good conditions at the proper time in the Fall of 1975. A visit to the field in June 1976 by the principal investigator indicated good prospects for an early harvest of Wabash when compared with other bluegrass varieties. A seed yield of 600 pounds per acre was estimated at that time.

FURTHER ROADSIDE EXPERIMENTATION WITH WABASH

The Wabash seed harvested the first year (in August 1976) after cleaning totaled 545 pounds. Ninety-five (95) pounds was retained as a seed source for filling out the current seed production field in Oregon and for the possible planting of future additional seed production fields and 450 pounds was used by ISHC to seed roadside experimentation plots on U.S. 41 in the vicinity of a new Raccoon Creek Bridge on Sept. 23, 1976. The following plots were established:

a. A six acre tract of Wabash;

b. A two acre tract of Wabash plus Purf Red Fescue;

c. A one acre tract of regular Highway mix;

d. A one acre tract of Wabash;

e. A one acre tract of Highway mix.

All site preparation was similar and was consistent with standard highway practices currently in use.

The amount of seed delivered was disappointing as earlier indications were that about 1500 pounds could be expected. The grower reported, however, that prior to harvest the variety had started to go down due to its fine straw character. He also noted that the stand was a little thin, which is normal for the first year of production. However, under full stand conditions he expected the variety to yield 700-1,000 pounds per acre. He was happy with the variety as a seed producer and would be willing to grow seed of the variety in future years.

The spring weather was cooler this year than normal with several late frosts occurring in the growing area as late as June 15. The Wabash bluegrass was pollinating about June 12. The freezing temperatures killed some of the pollen which resulted in reduced seed set. Also, the low temperatures did not allow normal development of the seed resulting in lower seed quality. In short, less seed was produced and greater clean out occurred in processing than normally would be expected.

PATENT PROCEDURES

It is standard procedure that any new seed developed at Purdue University be reviewed by a Varietal Release Committee of the Purdue University Agricultural Experiment Station. The principal investigator submitted a request for such review of Wabash bluegrass to the Committee in the summer of 1975. The request was returned for additional documentation.

In early 1976 the principal investigator provided additional documentation of the characteristics of Wabash (much of the material was that contained in the first sections of this Interim Report). On February 23, 1976, the Varietal Release Committee of Purdue University approved the release of Wabash Bluegrass.

Inasmuch as it is agreed that Wabash Bluegrass is a new variety having characteristics desirable for such uses as on roadsides, it is desirable to seek to patent Wabash. The claim for the patent would be that Wabash is a new and distinct variety of bluegrass plant, Poa pratensis, substantially as described in the early portions of this report, and particularly characterized by a medium green color, a vigorous rhizome spread, a medium tall seedhead and unusually uniform (apomictic) character - thus different, unique and useful wherever vigor is desired.

The following recommended program for patent application and exploitation of Wabash Bluegrass was developed:

1. PRF will submit as quickly as possible an application for patent on Wabash Bluegrass.
2. Title to Wabash Bluegrass will be retained by the Purdue Research Foundation and it will handle development and marketing of Wabash Bluegrass in an expeditious manner in accordance with good practice for maintenance of its integrity.

3. The U.S. Government and State and municipal governments will be able to obtain Wabash Bluegrass without payment of a seed royalty fee.
4. Purdue Research Foundation will provide a continuous supply of Wabash breeder seed, up to five (5) pounds every three years. This will:
   a. Require land for spaced individual vegetative clones located in the turf research area of the Agronomy Farm, Purdue University;
   b. Require periodic sterilization of soil to remove contamination;
   c. Require mechanical and chemical protection from encroachment;
   d. Require maintenance, water, fertilizer, and renovation of stand;
   e. Require relocation to new plots on a four year basis;
   f. Require hand harvest plus drying, thrashing, cleaning and storing of seed;
   g. Require delivery on request of breeders seed of the highest purity.

   (The above is a high cost annual commitment for as long as the cultivar is on the market; it must be the breeder's responsibility. On the basis of the seed needed (up to 5 lbs every 3 years) the cost could be equivalent to at least $100 per pound of delivered seed.)
5. The breeder will also go initially and likely annually to the Northwest where seed fields of foundation seed are grown, for liaison and education. He will prepare a description of the variety and maintain files with the certification and patenting agencies.

6. Purdue Research Foundation will provide the considerable expense of applying and securing the patent and direct the increase in availability of the cultivar 'Wabash', recognizing that all government units may obtain seed without payment of royalty.
7. PRF will assign the responsibility for increased propagation and merchandising of the cultivar Wabash to the Agricultural Alumni Seed Improvement Association of Romney, Indiana. That organization will write contracts with a seed processor. The seed processor will distribute the foundation seed, then advise the farmer-grower, then receive and clean the seed. Later the seed processor will combine the seed into lots for identity, testing, storage, packaging and distribution. The seed processor will ship to individual seed distributors.
8. The individual grower's fields will be observed and public relations maintained. This improves technology of seed production, plus the liaison with the grower is vital to continued trust and contracts.
9. The certification agency in each state will be informed as they inspect and approve the foundation class and certified class seed as produced in each individual farmer's fields. A service charge on all seed processed would be normal for handling the continued liaison and will include a royalty fee for seed sold to non-governmental agencies to be paid to PRF to cover its initial and continuing costs.

The process outlined which has been successfully developed and used by Purdue University for other developed seeds assures that adequate seed can be made available for either or both contract or open market purchase. When the seed becomes available, several seed houses can serve as retail bidders. These same houses can also supply other users - parks, playgrounds, airfields - as demand dictates.

To handle the seed development program as outlined, PRF requires that it have title to Wabash Bluegrass so that it has freedom to maintain seed stock, expand production and sell to other users in a responsible manner that will insure the integrity of certified Wabash Bluegrass seed and hopefully provide at least a recovery of its costs.

Subsequent to the development of the above recommended patenting and seed development process, PRF submitted a petition to the Department of Transportation requesting that Purdue retain title to the seed in order to maintain and multiply it. A copy of that petition and the resulting "Determination of Rights" by the Department of Transportation relative to the Wabash seed are included as Appendix A of this Report.

APPENDIX A

DETERMINATION OF RIGHTS

July 16, 1976

OFFICE OF PATENT MANAGEMENT

Mr. Harold P. Deeley, Jr.,
Patent Counsel,
Department of Transportation,
Room 10100C,
400 Seventh Street S.W.,
Washington, D.C. 20590.

Dear Mr. Deeley:

Under the auspices of the Joint Highway Research Project, School of Civil Engineering, with funds from the Indiana State Highway Commission, Professor W. H. Daniel was allocated money to develop a variety of Kentucky bluegrass adapted to highway roadsides. The variety was named Wabash.

This letter is to petition the Department of Transportation to permit Purdue to retain title to the invention in order to maintain and multiply the variety. If Purdue is permitted to retain title, we would propose the following program:

1. Purdue would provide a recurring supply of up to five (5) pounds of breeders seed every three (3) years. This program:

   a. requires land for spaced individual vegetative clones located in the turf area of the Agronomy Farm, Purdue University;

   b. requires sterilization of soil to remove any contamination;

   c. requires mechanical and chemical protection from encroachment to maintain purity;

   d. requires maintenance, water, fertilization and renovation of stands;

   e. necessitates vegetative relocation of plots every four years;

f. requires hand harvesting, drying, thrashing, cleaning and storing of seed;

g. means delivery as needed (probably no less than every three (3) years) of breeders seed of highest purity;

h. means ample seed supply must be available on demand to supply the need for foundation seed.

2. Purdue would negotiate an agreement with Agricultural Alumni Seed Improvement Association (Ag Alumni). Ag Alumni is a not-for-profit organization that produces foundation seed of Purdue developed plant varieties. Ag Alumni's responsibilities would include:

a. producing foundation seed;

b. contracting with two (2) or more seed processors in the seed-growing region in the Northwest for the production of certified seed.

Under an agreement, the seed processor would be responsible for plantings, certification of seed fields, receipt of clean seed, combining the seed into lots for identity, test, storage and distribution.

Ag Alumni would supervise the various aspects of the foundation and certified seed production. For this service Ag Alumni would collect a normal charge for the seed processed.

3. Purdue, at its expense, would file and prosecute a patent application on Wabash bluegrass.

It is understood that not only the U. S. Government but also State and municipal governments could obtain the seed royalty free. The agencies could contract with seed processors for any quantity of seed needed or purchase on the open market from the seed processors. It is further understood that purchasers other than government agencies would pay areasonable royalty.

If this proposal meets with your approval, we would be pleased to receive a document from you permitting Purdue to retain title to the invention of Wabash bluegrass.

Very truly yours,

R. L. Davis, Patent Manager

RLD:akw
cc: W. H. Daniel
M. Harshbarger
Ref: D-31-75

Copy retyped for clarity

May 20, 1977

Mr. Ralph L. Davis
Patent Manager
Purdue Research Foundation
Purdue University
West Lafayette, Indiana 47907

Dear Mr. Davis:

I enclose a signed copy of the "Determination of Rights" made by the Administrator, Federal Highway Administration, in response to your request of July 18, 1976. Under this determination Purdue retains title to "Wabash" bluegrass, subject to nonexclusive, nontransferable, paid-up licenses to the United States and to State and municipal governments. After Purdue files a patent application or applications, please have the license agreement attached to the "Determination," completed and returned to me.

Sincerely,

Orig. Signed by
Harold P. Deeley, Jr.

Harold P. Deeley, Jr.
Patent Counsel, TGC-15

Enclosure

HPDeeley:lz:5-20-77:TGC-15:69738
cc: TGC-1
TGC-15
FILED: Rights in Contractor Inventions (Reference)

Form FHWA 121 (Rev. 5-73)

UNITED STATES GOVERNMENT

Memorandum

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
Washington, D.C. 20590

DATE: MAY 16 1977

In reply refer to: HCC-50.7

SUBJECT: Determination of Rights in Invention

FROM: Acting Chief Counsel

TO: Mr. William M. Cox
HA-1 Federal Highway Administrator

Attached is a memorandum and supporting materials prepared by Mr. Deeley, the Department's patent counsel, pertaining to the determination of rights in a grass seed developed by Purdue University under a Highway Planning and Research contract.

Purdue has petitioned the Department to permit Purdue to retain title to this invention in order to maintain and multiply this variety of seed. The proposal submitted by Purdue meets all of the requirements of the Presidential Memorandum and Statement of Government Patent Policy. Purdue's proposed program will best assure development of the seed and its availability to the public.

We therefore concur in Mr. Deeley's recommendation that Purdue be permitted to retain ownership of the invention while the United States Government, State governments and municipal governments will be granted an irrevocable, royalty-free license under any patents that may issue on this invention. If you approve, please sign both copies of the attached Determination of Rights.

for Charles B. Hollis
Dowell H. Anders

Attachments

cc:
L. P. Lamm

Form DOT F 1320.1 (1-67)

UNITED STATES GOVERNMENT

DEPARTMENT OF TRANSPORTATI

OFFICE OF THE SECRETARY

Memorandum

DATE: May 5, 1977

In reply refer to:

SUBJECT: Determination of Rights in Invention

FROM : Patent Counsel, TGC-15

THRU: General Counsel

TO : Administrator, Federal Highway Administration

Attached is a "Determination of Rights" in an invention made by an employee of Purdue University in the course of work funded under the Highway Planning and Research Program (HPR-1). Purdue addressed their request to me as Departmental Patent Counsel. While I have the responsibility for investigating the background and preparing such determinations, I must refer them for signature to the operating administration that sponsored the work during which the invention was made.

Under Government patent policy as implemented by the Department of Transportation, the Secretary acquires by contract, the authority to determine the disposition of rights in inventions made in the course of the contract. By the delegation made in Section 1.45(a)(2), Title 49, Code of Federal Regulations, you have the authority to make such determinations relating to Federal Highway Administration contracts. Accordingly, I have prepared the "Determination of Rights" for signature by you or your designee. Purdue will retain ownership of the invention (a variety of Kentucky bluegrass called "Wabash") while the United States Government, State governments, and municipal governments will be granted an irrevocable, royalty-free license under any patents that may issue on the invention. I believe that this determination will best serve the public interest in this case, and I recommend that it be signed.

Harold P. Deeley, Jr.

Attachment

58972

DETERMINATION OF RIGHTS

The Purdue Research Foundation requests that they be permitted to retain title to an invention (the Subject Invention) made by Professor W. H. Daniel, School of Civil Engineering, Purdue University, in the course of the Joint Highway Research Project with the Indiana State Highway Commission. The contract was funded under the Highway Planning and Research Program (HPR-1) of the Federal Highway Administration. The Federal-Aid Highway Program Manual calls for recipients of Federal funds to include in their research and development contracts, provisions governing the allocation of rights in inventions that may be made in the course of the work. The Manual states that these provisions shall ". . . assure an equitable allocation of rights in inventions resulting from HP&R sponsored research and development contracts, to promote their expeditious development so that the U.S. public can benefit from early use of the inventions and to assure their continued availability." In this particular instance, however, the contract does not specifically contain a patent rights provision. Purdue has nevertheless reported the Subject Invention for which they seek to retain title, on the basis that a patent rights provision is implied in their contract.

The Subject Invention is a variety of Kentucky bluegrass known as "Wabash." Purdue seeks to retain title in order to bring the Subject Invention to the point of practical application through a detailed program that calls for specialized expertise and facilities. Purdue not only possesses these qualifications but has extensive experience in the exploitation of agricultural inventions. The program, which will maintain and multiply "Wabash," is set out in Purdue's request (copy attached). Such a program is clearly beyond the capabilities of the Department of Transportation itself; nor does the Department have the funds or the intention to sponsor development of the Subject Invention. Purdue's proposal, which meets all of the requirements of the Presidential Memorandum and Statement of Government Patent Policy (36 F.R. 16887-16892, August 26, 1971), will assure development of the Subject Invention and its availability to the public.

It is in the public interest that the Subject Invention be developed and brought to the marketplace where it will be available for general use. Purdue's program will constitute positive action to achieve that goal. Accordingly, the Federal Highway Administrator hereby determines that the most expeditious and effective way in which to bring the Subject Invention to the point of practical application is to permit Purdue to retain title to the Subject Invention, under the following terms:

A. (1) Purdue hereby grants to the Government a nonexclusive, nontransferable, paid-up license to make, use, and sell the Subject Invention throughout the world by or on behalf of the Government of the United States (including any Government agency). Purdue further grants to the State and municipal governments a nonexclusive, nontransferable, paid-up license to make or have made, use or have used, and sell or have sold the Subject Invention.

(2) Purdue agrees to grant to responsible applicants, upon request of the Government, a license on terms that are reasonable under the circumstances:

(i) unless Purdue, their licensee, or their assignee demonstrates to the Government that effective steps have been taken within 3 years after a patent issues on the Subject Invention to bring the Invention to the point of practical application, or that the Invention has been made available for licensing royalty-free or on terms that are reasonable in the circumstances, or can show cause why the principal or exclusive rights should be retained for a further period of time; or

(ii) to the extent that the Subject Invention is required for public use by Governmental regulations or as may be necessary to fulfill public health, safety, or welfare needs, or for other public purposes;

(3) Purdue shall submit written reports at reasonable intervals upon request of the Government during the term of the patent on the Subject Invention regarding:

(i) the commercial use that is being made or is intended to be made of the Subject Invention; and

(ii) the steps taken by Purdue or their transferee to bring the Subject Invention to the point of practical application or to make the Invention available for licensing;

(4) Purdue agrees to refund any amounts received as royalty charges on the Subject Invention in procurements for or on behalf of the Government and to provide for that refund in any instrument transferring rights to any party in the Subject Invention;

(5) Purdue agrees to provide for the paid-up licenses pursuant to paragraph A.(1) of this clause in any instrument transferring rights in the Subject Invention, to provide for the granting of licenses as required by paragraph A.(2) of this clause, and for the reporting of utilization information as required by paragraph A.(3) of this clause whenever the instrument transfers principal or exclusive rights in the Subject Invention; and

(6) Nothing contained in these terms shall be deemed to grant to the Government or to States or municipal governments any

rights with respect to any invention other than the Subject Invention.

B. Upon filing each patent application covering the Subject Invention, Purdue shall execute a license in the form set out in Exhibit A, in confirmation of the rights set out in A.(1), above.

L. P. Lamm

William M. Cox

For Federal Highway Administration

LICENSE TO THE UNITED STATES GOVERNMENT
STATES AND MUNICIPAL GOVERNMENTS

WHEREAS, _____ (Inventors), of _____, have invented _____ (Invention) (the Subject Invention) and filed a patent application thereon in _____, bearing Serial No. _____, filing date _____, and

WHEREAS, the invention was made in the course of research supported by funds from the United States Department of Transportation; and

WHEREAS, the United States Government is entitled to certain rights in and to said invention and application by reason of said support; and

WHEREAS, _____ (Institution), hereinafter called the "Licensor" has acquired by assignment from the inventors the entire right, title, and interest of the inventors to such invention;

NOW, THEREFORE:

1. The Licensor, in consideration of the premises and other good and valuable consideration, hereby grants and conveys to the United States Government a nonexclusive, nontransferable, paid-up license to make, use, and sell the Subject Invention throughout the

world by or on behalf of the Government of the United States (including any Government agency). The Licensor further grants to the States and to municipal governments a nonexclusive, nontransferable, paid-up license to make or have made, use or have used, and sell or have sold the Subject Invention.

2. The Licensor covenants and warrants that he has the right to grant the foregoing license, and that any assignment or license which he may make of the invention or the said patent applications or patents thereon, shall expressly be made subject to this license.

3. The Licensor agrees that the Government shall not be estopped at any time to contest the enforceability, validity, scope of, or title to, any patent or patent application herein licensed.

_____
Institution

_____
Signature

_____
Print or Type Name

_____
Date

_____
Official Title

CERTIFICATE

I, _____, certify that I am the _____ of Purdue; that _____, who signed this acceptance on behalf of Purdue is _____ _____ of Purdue; and that said acceptance was duly signed for and in behalf of Purdue by authority of its governing body and is within the scope of its corporate powers.

COVER DESIGN BY ALDO GIORGINI